BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Leak Detection by Infrared Photography - Case 730

DATE: November 30, 1967

FROM: C. E. Johnson
E. D. Marion

MEMORANDUM FOR FILE

One of the major problems in manufacturing propellant tanks for long term cryogenic storage is leak detection. Analyses have shown that leak rates greater than 10^{-9} Atm, cc/sec can significantly degrade the thermal performance of multi-layer insulation systems. These leak rates are at the limit of current detection technology even under laboratory conditions.

Most tanks manufactured so far have leaked the first time they were tested. The future holds many applications for cryogens in space, so we will be building many such tanks in the coming years. Clearly, new techniques are needed to leak check these tanks during the manufacturing process.

Sniffers can be used but this involves laboriosly examining every square foot of the tank area. To further compound the problem many of these leaks will only show up with the tanks in the cold and pressurized state. Hand held sniffers are not permissible in this condition. The only other leak testing technique is to put the whole tank in a vacuum chamber, fill it with the appropriate cryogen, and examine the gases present in the vacuum chamber using a mass spectrometer. This is obviously too cumbersome for use as a manufacturing leak check. And it will only tell you that you have a leak, not where it is.

A recent article* showed a technique using infrared photography for detecting heat leaks in a insulated railroad tank car. The tank car was filled with warm water and infrared sensitive photographs (thermographs) were made. Heat leaks showed up as bright spots on the photographs. This suggests a very neat and simple way to conduct a manufacturing leak test on cryogenic tankage.

*Science Digest, November, 1967, p. 41.

The tank in question will be insulated with multi-layer insulation and mounted in a vacuum chamber. The tank is then filled with the appropriate cryogen and allowed to come to thermal equilibrium. Thermographs are then made of the insulated surface.

Any significant leak will increase the local thermal conductivity of the insulation, which will in turn decrease the surface temperature. The article indicates that temperature differences as small as 1°F can be detected with the thermographs. With careful testing, this is enough to detect 2% degredation in the insulation. In addition to identifying a leak by its important effect (namely degraded insulation performance), the thermograph can show where the leak is and how bad it is.

We recommend that this approach be evaluated in more detail, perhaps to the point of conducting a quick-and-dirty feasibility test.

C. E. Johnson

1013-$\frac{CEJ}{EDM}$-sjh

E. D. Marion

Attachment
Figure 1

Infrared picture of insulated tank car will show location of heat leaks. The car was filled with hot water, left standing on track for a day, then photographed. The white spots in second thermogram below show hot points indicating heat leaks.

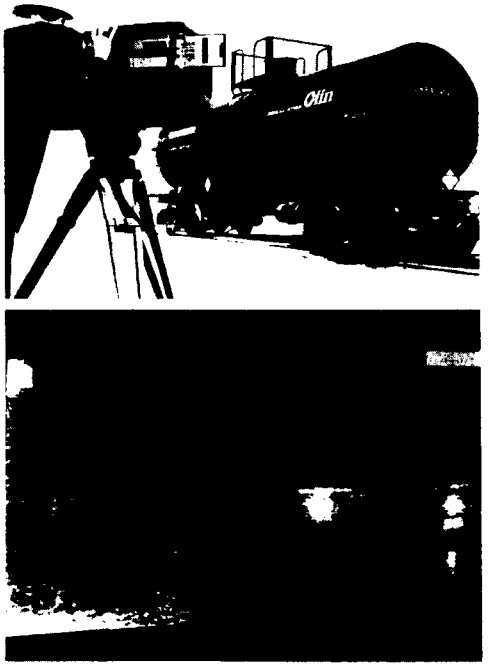

FIGURE 1 - INFRARED PICTURE OF INSULATED TANK CAR

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